Grid Control Centre

South of Scotland Electricity Board

Strathkelvin House

Grid Control Centre

of the

South of Scotland Electricity Board

System Operation Engineer
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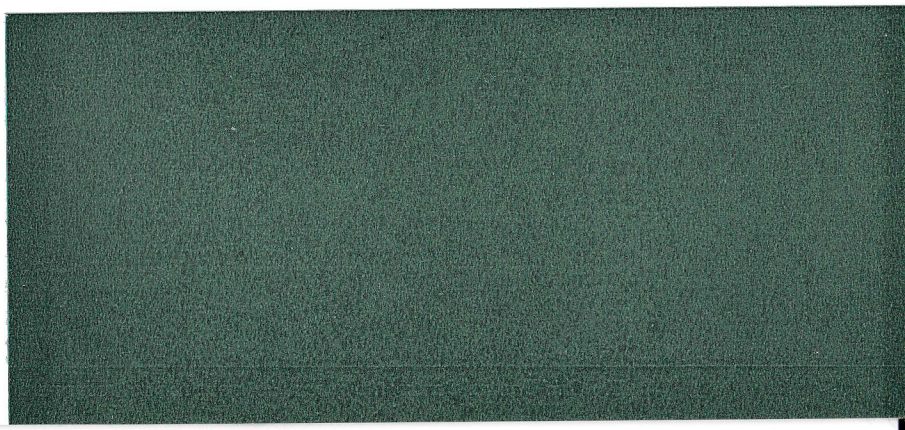
Introduction

Strathkelvin House, the Grid Control Centre of the South of Scotland Electricity Board was commissioned in the spring of 1972. Standing on rising ground at Hayston near the Dunbartonshire town of Kirkintilloch, the new centre replaces an earlier one in the same area.

Transmission lines interconnecting the Board's power stations form a network which is part of the National Grid system. The operations of the Grid Control Centre are based on the switching of power lines in compliance with the Board's safety regulations; the security of the system to consumers; and the ordering of generating plant—which is to run and what it is to produce—so that the aggregate output of the power stations matches the consumers' demand at the lowest available cost.

While the layout of the centre caters for present requirements it has been designed with an eye to the future. Equipped to accommodate change and expansion in the 'seventies, 'eighties and 'nineties, it has the flexibility to meet further needs beyond the turn of the century.

Some 80 people are employed, including control, telecommunications and maintenance engineers and administrative staff.



The Grid Control Centre; the spaces between the buttresses are glass-roofed.

Site and architecture

Built at the top of a grassy slope, the centre is sheltered by tall trees yet has uninterrupted views northward to the Campsie Fells and southward across the River Kelvin and the town of Kirkintilloch.
The building, shown on Page 4, is faced with white granite-based precast concrete above and below a broad band of contrasting brown ceramic tiles. The buttresses around the lower part of the building characterise its stability and lend themselves to a useful extension of the floor area which provides some extremely well-lit offices and workshops under a sloping glass roof.
Most of the north end of the building is occupied by the control room on the second floor, the communications apparatus room on the ground floor and between them, on the first floor, a cable loft giving easy access to the wiring. The control room is floored with removable tiles which can be lifted so that leads may be brought up to suit the layout of equipment. At the south end are administrative offices and a staff canteen.
From this building the whole system of power supply and transmission in the south of Scotland is controlled.

Power supply and transmission

In Britain there are three authorities responsible for the generation and transmission of electricity. The South of Scotland Electricity Board are responsible for the south of Scotland, the North of Scotland Hydro-Electric Board for the north of Scotland and the Central Electricity Generating Board for England and Wales. The power stations of all three authorities feed into the National Grid, but each authority controls the power stations and grid transmission lines in their own area.

Power stations

The map on Page 15, shows the power stations of the South of Scotland Electricity Board, with distinctive symbols indicating the different types.
There are wide differences in what amounts of electricity the power stations produce and the ways in which they produce it. Longannet, the largest in Scotland, is a coal-fired station with a capacity of 2 400 megawatts—enough to supply all the south of Scotland on a Spring day; Stonebyres, hydro-powered, produces only five megawatts.
Coal and oil-fired ("conventional") stations provide most of the output and the remainder is produced mainly by nuclear power stations with smaller contributions from hydro-electric (including pumped-storage) and gas-turbine stations. Start-up time from cold for conventional stations is measured in hours, for nuclear stations in days, while for hydro-power and gas turbines it is a matter of minutes.

National grid

Covering the whole of Britain, the National Grid is the largest fully interconnected transmission system in the world. The principal grid transmission lines in the south of Scotland are shown in the map on Page 15. Grid switching stations are sited at each power station, and at other key points (as shown) throughout the system. Power stations and grid switching stations are called into operation from the Grid Control Centre in accordance with forecasts of demand and plans for supply.

Forecasting the demand

Demand for electricity in the south of Scotland may vary from less than 500 megawatts on a summer's night to more than 4,000 megawatts on a winter's evening.

In making their forecast of demand, the Grid Control Centre staff must take into account not only the established pattern of seasonal, weekly and daily variation, but also the effect of more elusive factors such as fluctuating weather, public holidays; or perhaps a popular television programme, at the end of which cookers and kettles are similtaneously switched on in half-a-million homes.

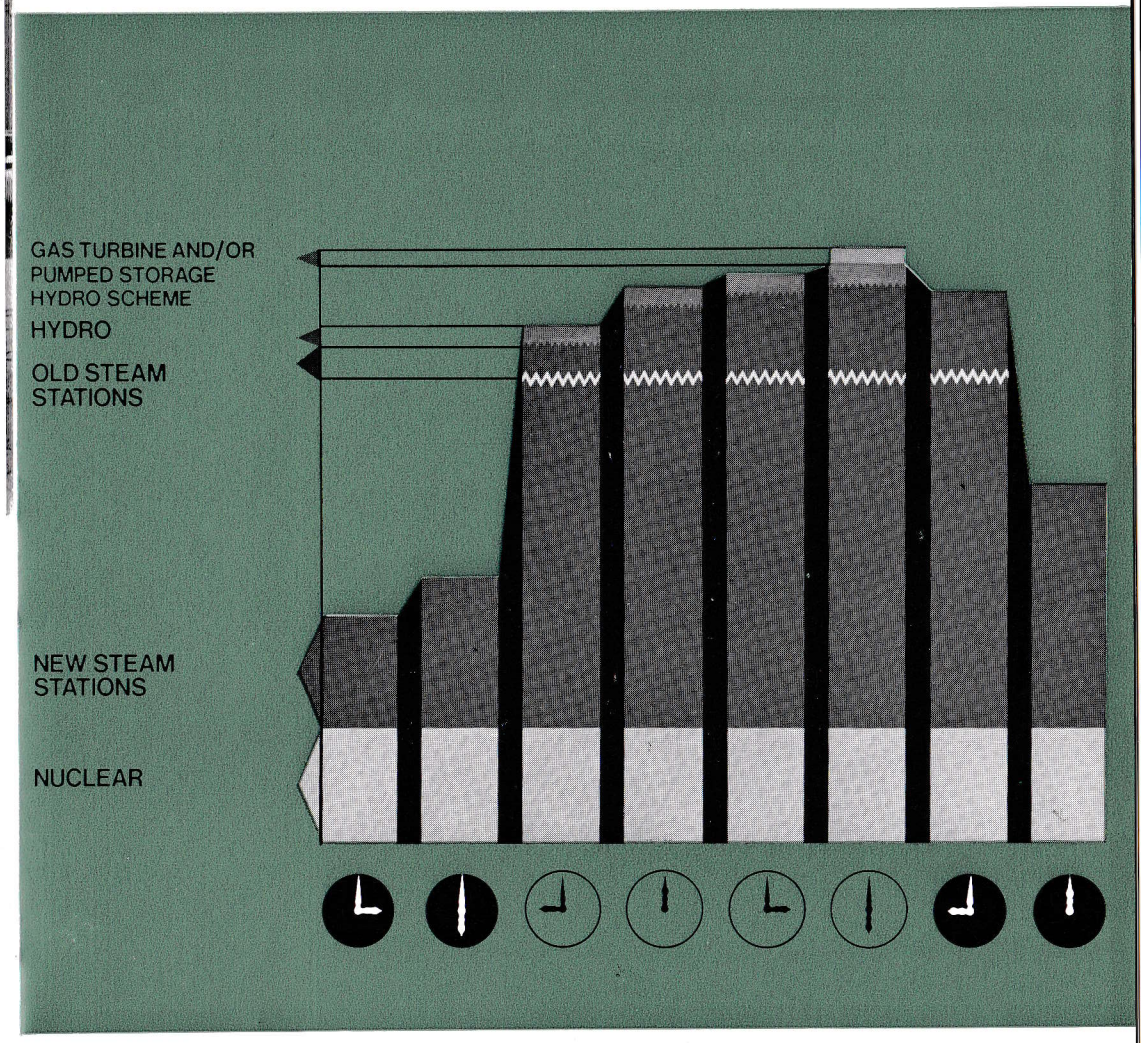
Planning the supply

Each week the staff review their forecast of the demand and consider its implications, then decide how best to deploy the power stations and arrange the Grid power lines to meet the situation.

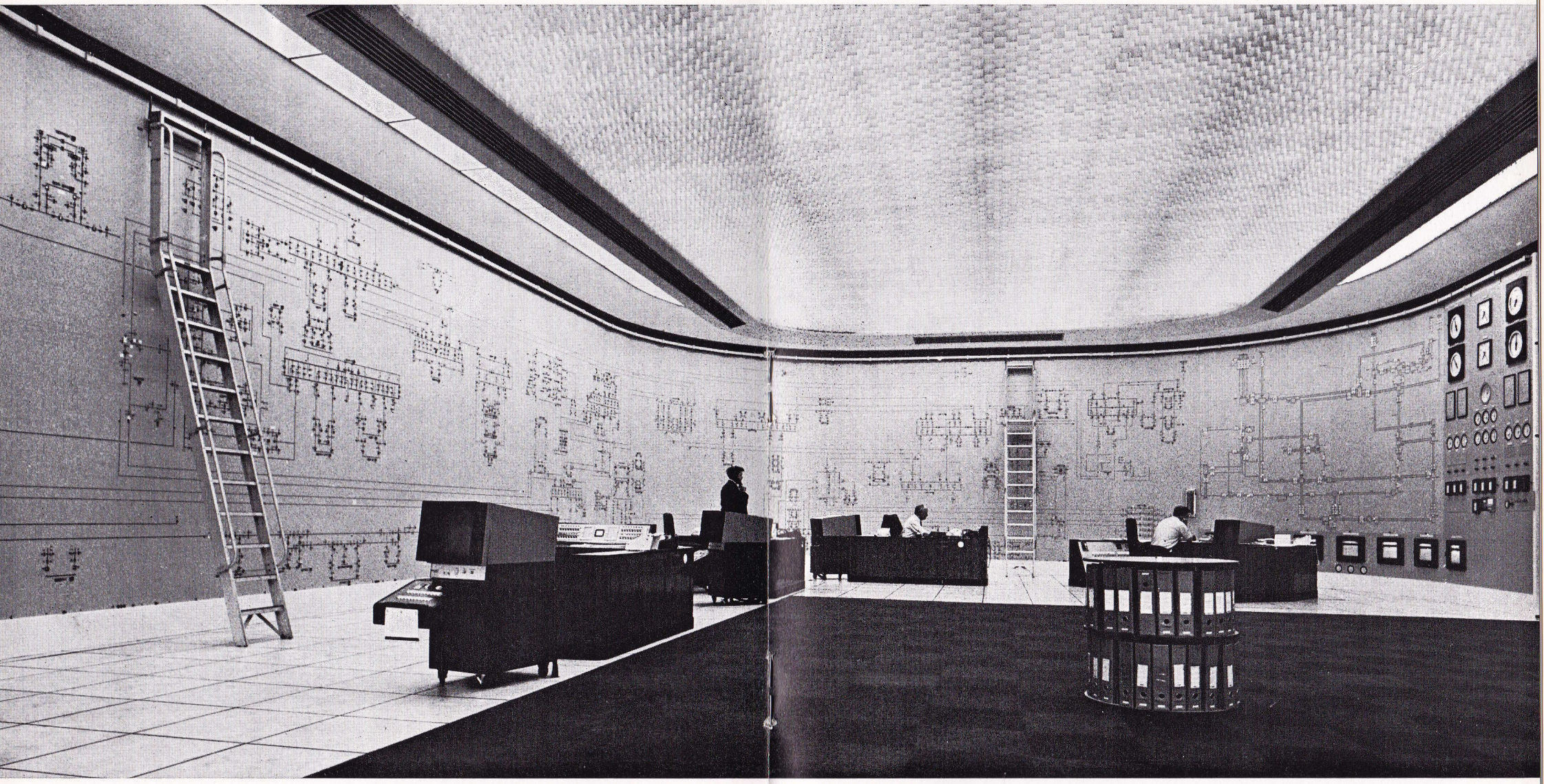
The diagram on Page 7 shows how this works during a typical 24-hour period. The height of the panel above each clockface represents the power being consumed at about that time. Sub-divisions within each panel show what proportion of the total is contributed by each type of station.

A merit order of power stations is established, whereby the lowest-cost-of-production plant makes the highest contribution. Thus the nuclear stations, because their running costs are least, are never shut down; and the newer conventional stations are run as nearly as possible for 24 hours a day year in, year out. The older steam stations generate during the day and close down at night and weekends. Hydro-electric stations and gas turbines are called in only at times of heavy demand or emergency.

A detailed programme based on these principles is worked out for the week and is verified with the Board's computer in Glasgow, using a data link. This programme provides a basis for the operation of the system; but in practice, continual adjustments are required to cater for unpredictable variations.



How the varying demand is met: the panel above each clock-face shows the proportion of the total which is contributed by each type of station.



Control room: the desks, from right to left, are used by the despatching engineer, the senior grid control engineer, the switching engineer and the assistant switching engineer.

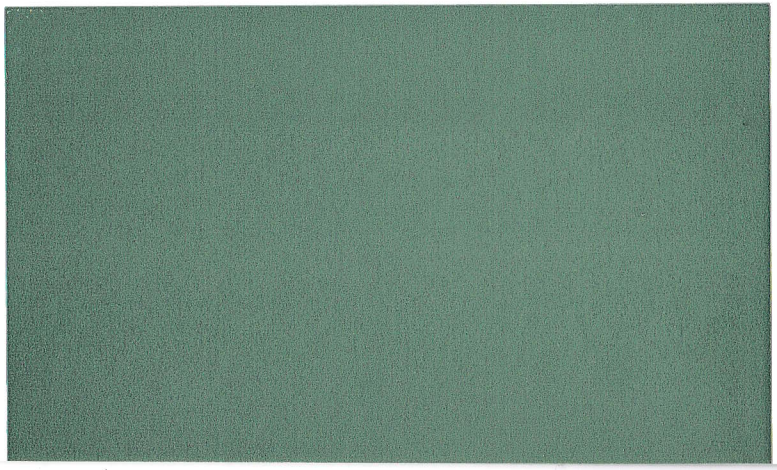
Control room

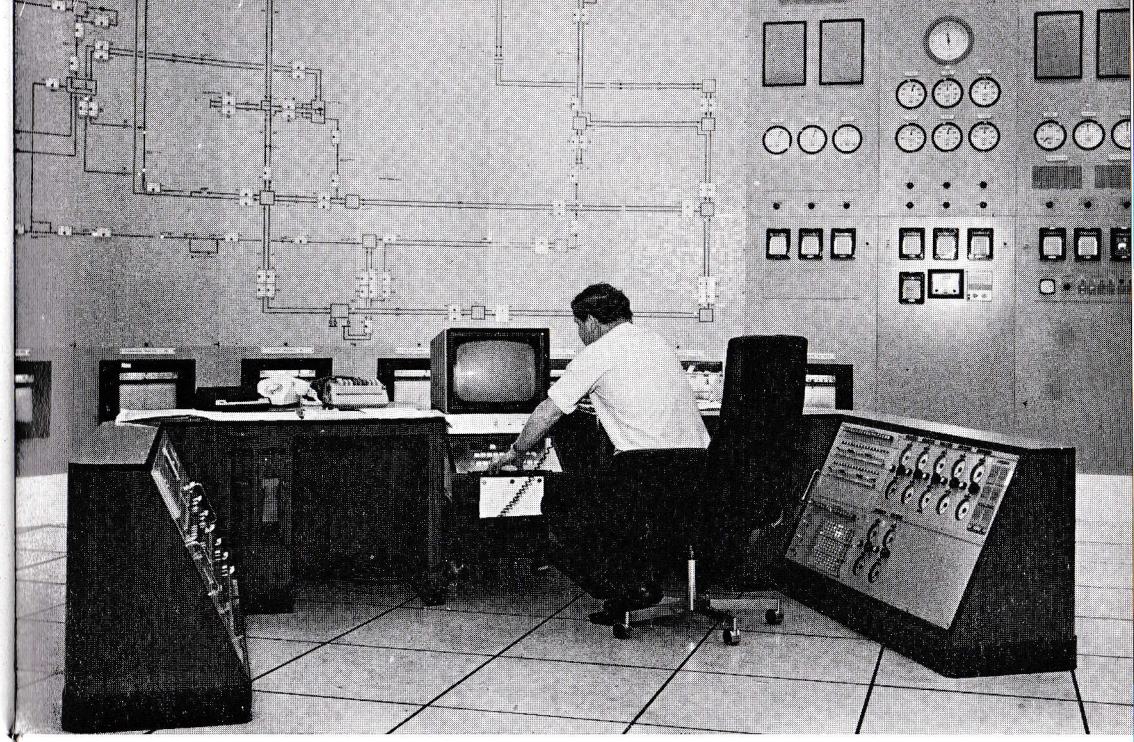
The control room, shown on Page 8-9, is manned 24 hours a day, in eight-hour shifts. The room is air-conditioned, sound-insulated and fitted with glare-free illumination of instantly adjustable brilliancy. In front of a large diagram of the Grid, which occupies more than half the wall space, are four special desks for the control staff. The senior grid control engineer, who is in overall charge of the shift, sits in the centre flanked on his right by the despatching engineer, who faces the load-flow diagram, and by the switching engineer on his left. The fourth desk is occupied at busy times by another assistant switching engineer.

The despatching engineer's desk is shown opposite.

Radio and telephone handsets, both with push-button control, provide communication with power stations, grid switching stations, other control centres and key transmission maintenance centres. To reduce the noise level, a quiet-speaker intercom system is used for conversation within the control room and with senior staff elsewhere in the building.

To the right of the desk is a cathode-ray tube unit on which is displayed on request, through the centre's computer, data from power stations and power-line load-flow information. The display is not televised in the popular sense; it is formed directly from incoming telemetry (measurements received from a distance in coded form, subsequently decoded and displayed in conventional form). Equipment similar to the foregoing is installed at each of the three other desks.





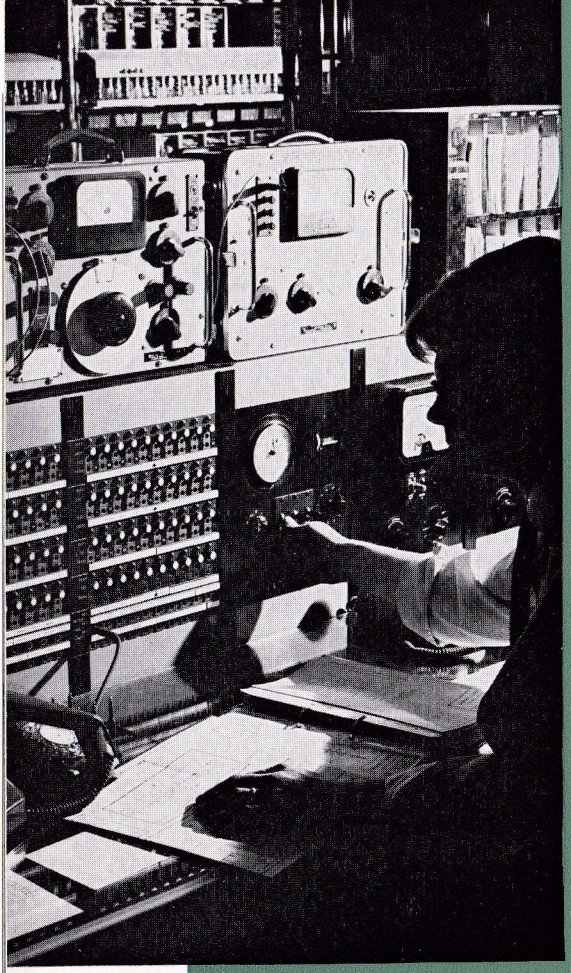
Despatching engineer's desk and displays.

Despatching engineer

The despatching engineer faces the wall panel of meters and moving charts which indicate and record the state of supply and demand. He constantly compares the actual situation with the planned programme and passes to the power stations instructions to correct variations from the planned programme.

Normally, he orders some generators to be run at less than full load, so that together they have sufficient reserve to absorb the sudden failure of the largest generator in use. Spare steam generating plant is kept in readiness to start up. If possible, other plant capable of running at very short notice (gas-turbine or hydro stations) is kept in reserve and for these stations he has a special display console and telegraph system on his right.

It is an important duty of the despatch engineer to arrange inter-changes of power with the Central Electricity Generating Board and the North of Scotland Hydro-Electric Board, and to engage in the constant trading between north and south. Scotland and England and Wales buy and sell surplus power from and to each other at agreed prices, and the arrangements are reviewed every few hours.



Test panel from which communications apparatus can be tested.

Data processor which converts incoming data signals into a suitable form for display.

Switching engineer

The switching engineer is responsible for maintaining supplies throughout the Grid without overloading any part of it. He is also responsible for authorising work on the Grid and for ensuring that lines on which men are working are switched off and made safe in accordance with the Board's safety rules.

The switching engineer makes constant use of the wall diagram of the Grid pictured on Pages 8, and 9. To enable this diagram to be easily amended, it is built up in a mosaic of over 180 000 detachable plastic tiles. In addition to the painted lines and symbols on the diagram, there are model switches which are set to show the condition of the actual switches on the Grid. Some of these models incorporate lamps which indicate when a switch has opened or closed to show a discrepancy between the model and the original.

Communications

One of the essential requirements of a Grid control centre is security of communications. The site of the centre was carefully chosen in order to obtain maximum diversity of communication circuits and security of power supplies.

The major part of the Board's communications is provided by rented Post Office circuits but these are backed up by the Board's private pilot cable network. Radio contact is also available to all major stations in the event of failure of land lines.

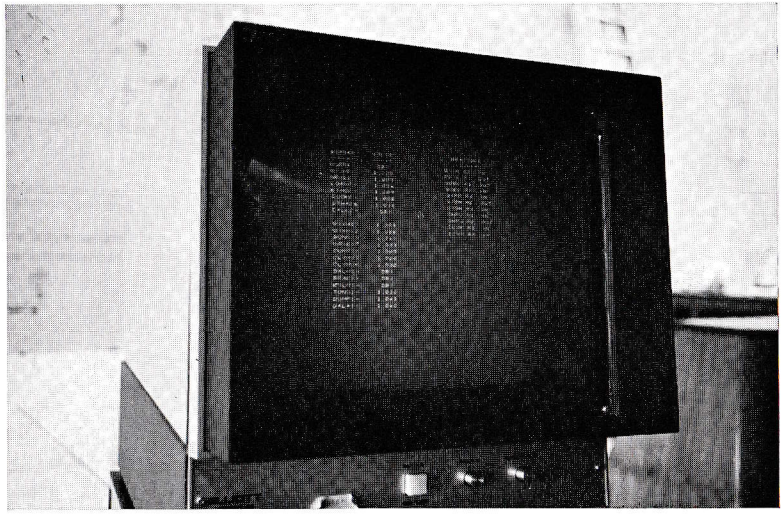
Each telephone line emanating from the building carries not only a telephone conversation, but also up to ten above-speech signalling channels. The latter are used for telemetering, signalling of circuit breaker and alarm conditions, telephone calling, telegraph instructor and teleprinter signalling, etc. (Used in this way, less than 30 lines are needed to carry the communication traffic of the centre.)

The telemetry system, which conveys measurements of the outputs of power stations, power flows on the Grid lines, system voltage and frequency from outlying points in the network, is of considerable technical interest. Each reading to be transmitted is converted into a series of pulses the repetition rate of which is proportional to the magnitude of the reading. By means of multiplex units up to 15 of these readings can be transmitted over one signalling channel. In this way some 500 telemetered quantities are conveyed to the control centre. The outputs from the multiplex decoders are each connected to telemeters which give a direct current output proportional to the impulse rate to drive the display instruments in the control room.

A data processor, part of which is shown on Page 12, also scans the outputs of all the telemeters, converts them into digital form, adjusts the scaling, and finally generates the alpha-numeric information to "write" the required letters and numbers on the cathode ray displays in the control room. An example of the resulting display is shown on Page 14.

Achievement

It is worth recording that the South of Scotland Electricity Board have, in this Grid Control Centre, a combination of layout, technical equipment and expertise which is comparable with the most advanced installation anywhere.



Cathode-ray tube unit in the control room displaying selected incoming data.

Consultants and principal contractors

Architects	Baxter, Clark and Paul, Glasgow.
Quantity Surveyors	Robert Mackintosh and Partners.
Consulting Engineers	Wallace Whittle and Partners.
Structural Engineers	W. A. Fairhurst and Partners.
Main Building Contractor	Hugh Leggat Ltd.
Equipment for control room and communications apparatus room	G.E.C.—Elliott Process Automation Ltd. Plessey Co. Ltd. Standard Telephones and Cables Ltd. Telephone Manufacturing Co. Ltd.

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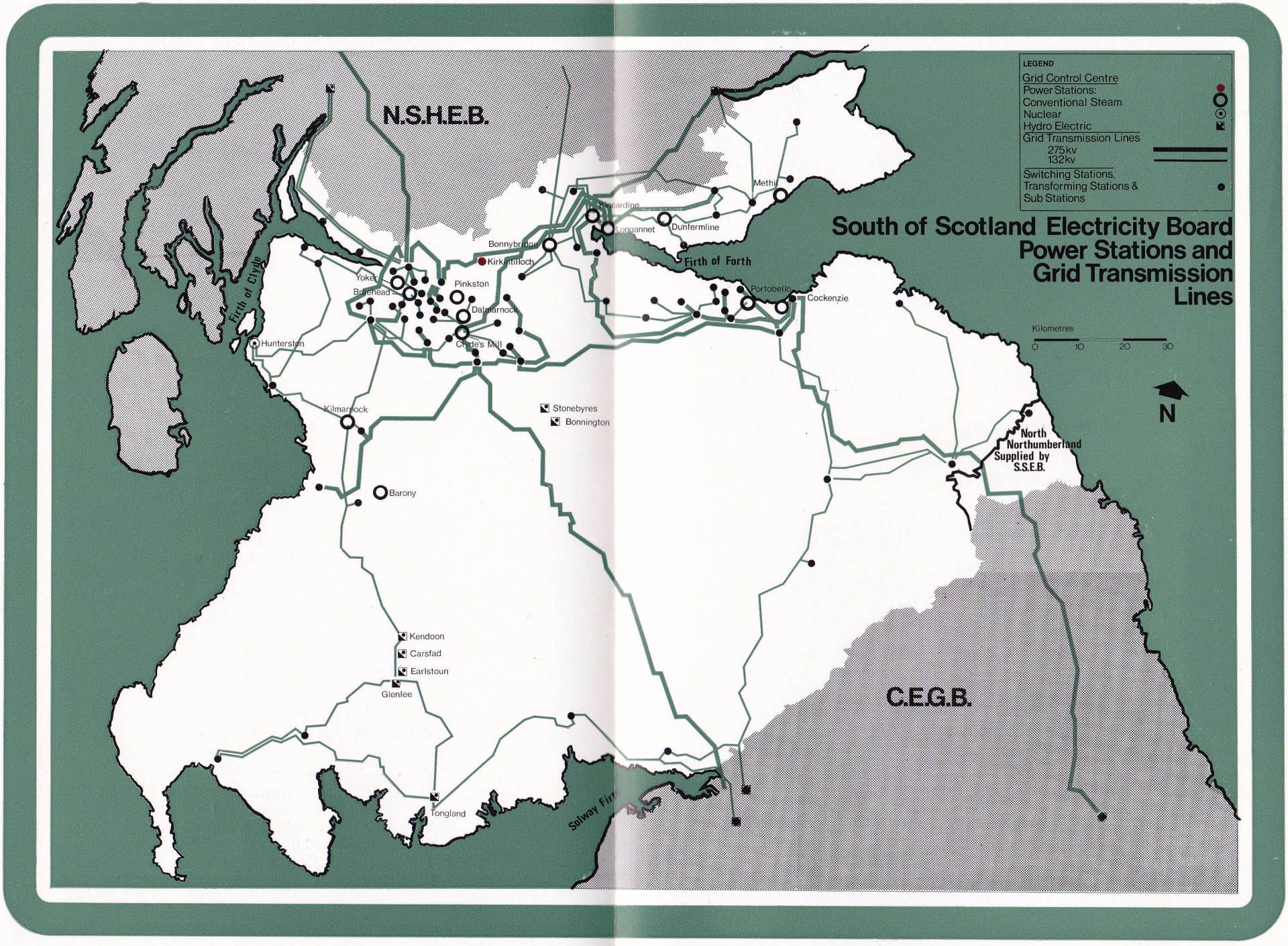
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